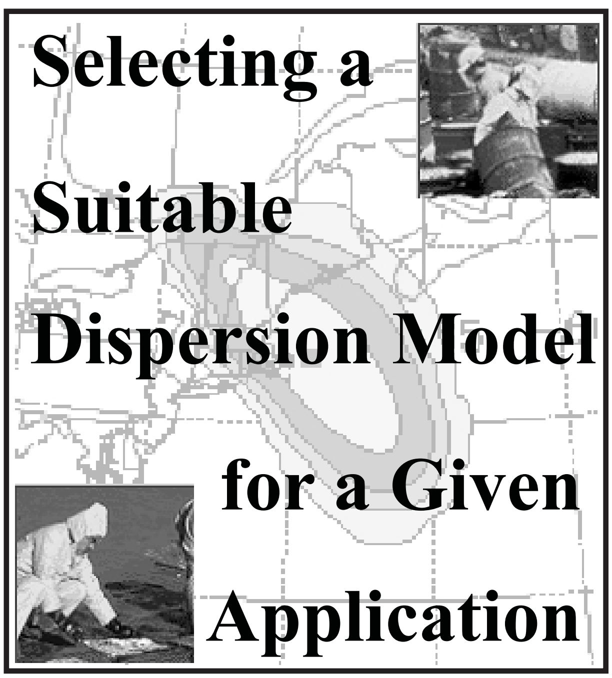
U.S. DEPARTMENT OF COMMERCE/ National Oceanic and Atmospheric Administration

OFCM

OFFICE OF THE FEDERAL COORDINATOR FOR
METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH

PROCEEDINGS OF THE WORKSHOP ON EFFECTIVE EMERGENCY RESPONSE



December 5-6, 2001
Crystal City, Virginia

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8455 Colesville Road, Suite 1500
Silver Spring, Maryland 20910

PROCEEDINGS

OF THE

WORKSHOP ON

EFFECTIVE EMERGENCY RESPONSE

Selecting a Suitable Dispersion Model for a Given Application

December 5-6, 2001

Crowne Plaza Washington National Airport
Crystal City, Virginia

Washington, DC
May, 2002

FOREWORD

The Workshop on Effective Emergency Response was held December 3-5, 2001 at the Crowne Plaza Washington National Airport Hotel, Crystal City, Virginia. The theme of the Forum was "*Selecting a Suitable Dispersion Model for a Given Application.*" A cross-section of nearly 90 people participated in the workshop, including representatives of the government, private, academic, and other sectors. The workshop was sponsored by the Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM).

The purpose of the workshop was to address issues associated with the number and variety of atmospheric transport and diffusion (ATD) models existing today in the federal government. In particular, participants considered what models should be used in particular situations and how those models are evaluated.

The overarching goal of the workshop was to *define a framework for supporting the objective determination of the most appropriate dispersion model to be used in a given situation.* To achieve this goal, the following objectives were pursued:

- Selection of categories to be used for screening dispersion models for application in a given scenario.
- Development of appropriate criteria within the selected categories to be used for objective screening of models.
- Introduction of processes and discussion of critical issues relating to model evaluation.

This document summarizes the proceedings of the workshop, captures the recommendations of the breakout sessions and panels, and summarizes the issues and actions that were addressed and proposed at the workshop.

I wish to extend my deepest appreciation to the panelists, moderators, rapporteurs, and attendees whose lively involvement, interaction, discussion, and interest made this workshop a success.

Samuel P. Williamson
Federal Coordinator for Meteorological Services
and Supporting Research

PROCEEDINGS

of the

Workshop on
Effective Emergency Response

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INTRODUCTION

Mr. Samuel P. Williamson
Federal Coordinator
Office of the Federal Coordinator for
Meteorological Services and Supporting Research

Welcome

After welcoming participants to the workshop, Mr. Williamson provided background information on the Office of the Federal Coordinator for Meteorology (OFCM). The mission of OFCM is as follows:

> *To ensure the effective use of federal meteorological resources by leading the systematic coordination of operational weather requirements and services, and supporting research, among the federal agencies.*

OFCM works through a suite of program councils, standing committees and working groups, and short-term joint action groups to facilitate cooperation among the agencies[*] that are involved in meteorological activities.

Moving on to the workshop, Mr. Williamson provided a recent history of OFCM activities relating to atmospheric transport and diffusion. In June 2000 OFCM hosted the Workshop on Multiscale Atmospheric Dispersion Modeling within the Federal Community. Since that time the OFCM Joint Action Group on Atmospheric Transport and Diffusion has met three times. In October, in response to the terrorist attacks of September 11th, OFCM formed the Working Group on Environmental Support to Homeland Security, which has been meeting regularly in October and November 2001. The issue of atmospheric transport and diffusion has figured prominently in these meetings. Also in November the Federal Committee for Meteorological Services and Supporting Research met and endorsed this workshop.

The overarching goal for this workshop is to **define a framework for supporting the objective determination of the most appropriate dispersion model to be used in a given situation.**

To achieve this goal, the following objectives will be pursued:

- Select categories to be used for screening dispersion models for application in a given scenario.
- Develop appropriate criteria within the selected categories to be used for objective screening of models.
- Introduce processes and discuss critical issues relating to model evaluation.

[*] Departments of Agriculture, Commerce, Defense, Energy, Interior, State, and Transportation; EPA; FEMA; NASA; NRC; NSF; NTSB; OMB; and OSTP.

Several additional considerations were cited. Depending on the source of information, the number of federal atmospheric transport and diffusion models can range as high as 150 to 200. These fall into several categories, including response models, air quality and regulatory models, and research and development models. A number of different processes are used across the federal government to evaluate the fitness of atmospheric transport and diffusion models for their intended use. Recent events dictate the application of an aggressive timeline in addressing these issues.

INTRODUCTION

Col Judson E. Stailey, USAF
Assistant Federal Coordinator for
Air Force and Army Meteorological Affairs,
Office of the Federal Coordinator for
Meteorological Services and Supporting Research

Set the Stage

Recent events have focused attention on the potential for release of agents that could threaten the health or lives of large groups of citizens and, in turn, on how we in the meteorological community support the response to these types of incidents. As we begin to focus on this challenge, the first thing we notice is the large number of ATD models available, a result, apparently, of the bottom-up approach to ATD model development that has taken place in the US. When we look further into how these models support emergency response, we see that, because there are several response plans that designate different Lead Federal Agencies, a number of different models may be available for use depending on the situation. There is even some potential for more than one model to be applied in a given situation, leading to the possibility of conflicting information being passed to responders. None of this should be new information to those in the ADT community. What's new is the spotlight that has been focused on this situation and urgency for addressing it.

This workshop is the stepping off point for addressing this situation. Mr. Williamson has already discussed the workshop goal and objectives. This presentation will provide a little background information and define some terms to help us get started.

How Many Models?

In 1999 OFCM published an update to their ATD model directory, called Directory of Atmospheric Transport and Diffusion Consequence Assessment Models. This directory included information on 64 models, and some people often cite that number as the number of available federal models. That's really not the case, however. The directory includes models from outside the US, and includes only those models for which the developers or users responded to the request for information about their models. When FEMA conducted a review of models to determine what they should use, they looked at 144 models. Others have suggested that there are over 200 dispersion models. Numbers like this get people's attention. We saw that happen at the Federal Committee meeting Mr. Williamson mentioned a few minutes ago.

This situation begs the question "If we have an emergency involving the release of a dangerous substance, what model will we use?" It also suggests a follow-up question: "Why do we have all those other models?"

Now, I recognize that these questions reflect a serious over-simplification of the situation. However, at some level they also reflect valid concerns. A good way to answer those concerns would be to obtain a clear, objective understanding of the characteristics of dispersion models. Such an understanding, perhaps documented in the form of a searchable database, would also support the selection of models that are appropriate for use in specific situations.

Types of Models

Before going into more detail on characterizing ATD models, we should think about what models we will be considering here. There are, of course, a lot of ways to categorize models, but for our purposes here we could think of models as being either research or operational. Not every model will necessarily fit neatly into one of these categories, and some may object to categorizing them in this fashion. However, as we are addressing operational scenarios in this context, this approach seems to be a practicable way of separating out a number of models that should not be considered because they are not useful in emergency response.

Categories and Criteria

In order to understand the characteristics of the models, we have proposed gathering information on them in a standard way. Model characteristics can be defined in terms of specific questions you might ask about models and the answers to those questions. The subject of a question is referred to as the "category" and the answers as "criteria." Unfortunately, there has been some difficulty articulating what is meant by "category." To help explain the term, consider an example. The category "range" would come from the question "At what distance from the source does this model provide information?" The question "How long does it take to run the model?" would define the category "runtime."

Application	Boundary Features (land-sea, urban, etc.)
Target User Community	Deposition
Range	Weather Input
Resolution	Source Implementation
Time Steps (steady state, time dependent)	Effects Implementation Platform
Type of Diffusion Module (Gaussian, CFD, etc)	Environment Runtime
Type of Transport Module (prognostic, stochastic, etc)	Status of Evaluation Accuracy
Terrain Implementation	On-going Development

Table 1. Strawman List of Categories

Table 1 shows a strawman list of categories. It is not intended to be definitive, or perhaps not even a starting point. It simply illustrates the concept. Something like it, only better, should come out of this workshop. This list certainly could use improvement. For example, when considering the category "application" one might come up with criteria like "chemical, biological, radiological" etc. That seems pretty straightforward, but when considering the concept of "application," a colleague proposed the criteria "planning, response, assessment, clean-up." This suggests that there are at least two dimensions to the term "application."

Perhaps a way to resolve this ambiguity would be to define a category called "threat" for the chemical, biological, and radiological criteria. In any case, this illustrates the challenges facing this workshop.

As mentioned earlier, the "criteria" associated with a category could be thought of as potential answers to the question that defines the category. Possible criteria for the category "application" have already given been suggested. Consider the category "range," which was cited earlier. Criteria under range might be, say, source to 1 km, 1-10 km, 10-100 km, 100-1000 km, and greater than 1000 km. Of course, for a given model more than one range might apply. That approach works for the scientist in all of us, but users may want to specify it differently, perhaps using descriptive terms like city block, urban area, metropolitan area (or county?), state, region, continent, hemisphere. These are the types of issues to be considered as the list of criteria associated with each category is being developed.

Two additional points should be made. First, we should realize that the questions that define the categories also express what is important to us, and, as such, are related to requirements. So, while we're not actually considering requirements at this workshop, some of what we will be doing will be addressing requirements at least obliquely. We should not forget this. Going back to the 64 (or 144, or whatever) models we have, it's fair to ask which requirements those models were built to meet. Perhaps what we do here will move us toward being able to answer that question in an objective way.

Finally, one of the categories on our strawman list should be highlighted—status of evaluation. It comes from the question "What have you done to make sure that your model will give me what I need and that what it gives me is correct?" We have a responsibility to use tools that work properly, and to understand how well they work. It should be obvious, given recent events, that everything associated with a disaster is going to be put under a microscope by someone. We need to make sure that we've done our homework in this regard. Tomorrow we will be having a panel discussion on agency approaches to evaluating models, which will be a starting point for further work in addressing this issue.

PANEL DISCUSSION

Panel 1: Selection of Screening Categories for Models

Moderator: Mr. Bruce Hicks, *Director, Air Resources Laboratory, National Oceanic and Atmospheric Administration*

Rapporteurs: Mr. Rickey Petty, *Program Manager, Office of Biological and Environmental Research, Department of Energy*

Mr. Ronald Meris, *Defense Threat Reduction Agency*

Synopsis

The objective of this panel was to discuss the model screening criteria considered important by the agencies for various applications. For example, applying a dispersion model for an atmospheric chemical release from a storage area, model-screening criteria might include such things as range, source characterization, model runtime, and input requirements. The idea was to start with a strawman list of criteria and have each panelist add those criteria considered important by their agency. The criteria list would then serve as input for breakout groups that would define specific thresholds within each criterion. After considerable discussion following the panelists' presentations, it was decided to adopt a scenario-based approach. This would link the criteria to potential real-world threats. The goal is then to establish criteria for selecting suitable models for each scenario. In a meeting of key participants, which followed the general session, four scenarios were selected based on terrorist threats: an anthrax release from a crop duster, a "dirty nuke" release, an urban release of sarin, and an airplane crash into a nuclear power plant. It was further decided that each of the three breakout groups scheduled for the next morning would focus on model criteria needed to address these scenarios in one of three phases of operations: planning, response, or recovery.

Selection of Screening Categories for Models: Model Uncertainty

Mr. John S. Irwin, NOAA Meteorologist
EPA Office of Air Quality Planning and Standards,
Air Quality Modeling Group

ABSTRACT

The Chemical Emergency Preparedness and Prevention Office (CEPPO) provides direct support in emission characterization and assessment for emergency situations. For emissions from large-scale disasters, the Office of Air Quality Planning and Standards provides expertise in assessing possible longer-term (chronic) heath and ecological risks. Any screening criteria for models must include health effects.

Assessing health effects involves following individuals through their daily activities in order to determine exposures. All other factors being equal, the further from a release, the less attention needs to be given to initial dilution and buoyancy effects. Also, lacking estimates for the mass of emissions released and considering the chaotic interplay of various scales of motion, little can be said beyond where exposures may occur. Results from tracer experiments suggest that at best the uncertainty in estimating the plume's position will be on the order of one quarter of the plume's width in the near field, with larger position uncertainty as the transport distance increases. Having a position uncertainty of this magnitude would result in at least a factor of two in the uncertainty of concentration estimates. There are also uncertainties in characterizing the initial dilution and buoyancy which begs the question, at what level of uncertainty do concentration estimates become worthless?

However, whereas the modeling for a particular event may be highly uncertain, estimates of what might be seen "on average" for this situation may be quite accurate. The difference is whether one is testing a model's ability to replicate the average concentration pattern (assuming one could average observations taken by sampling many realizations taken from the same ensemble) versus testing a model's ability to replicate what might be seen in any one realization.

Selection of Screening Categories for Models: DOD Perspective

Captain Frank Garcia, USN
Acting Director, Information Systems,
Deputy Under Secretary of Defense (Science & Technology)

ABSTRACT

The selection of dispersion models within the Department of Defense is driven by mission considerations including strike/counter proliferation, defense/force protection, and facilities readiness. Interim accreditation has been given to VLS TRACK (defense/force protection), HPAC (strike/counter proliferation), and D2PC (facility readiness). Other factors entering into the selection process include a convergent acquisition process, transportability, interoperability, and integration with service doctrine. Recognizing the need to strengthen oversight, the Department of Defense is taking a top-down approach in defining the lines of authority for chemical and biological programs.

The Department of Defense recognizes that hazard prediction includes more than atmospheric transport and diffusion; it also includes better source characterization and a better understanding of human response.

Over the next few years, the Department of Defense will develop the Joint Effects Model (JEM) as a common-use hazard prediction model. This model will integrate capabilities of current models within a common architecture as well as develop and integrate urban effects and flow through complex structures. The goal is to provide real-time information for operations including support for homeland security.

Selection of Screening Categories for Models: FEMA Perspective

Mr. Paul Bryant
Insurance and Mitigation Division,
Federal Emergency Management Agency

ABSTRACT

Under the Catastrophic Disaster Response Group (CDRG), Emergency Support Information Requirements (ESIRs) have been gathered for various Emergency Support Functions (ESF) under the Federal Response Plan including Hazardous Materials. As part of the multi-hazard risk modeling assessment for the Hazardous Materials ESF, a number of models were evaluated as to how well they satisfied Emergency Support Information Requirements. The model evaluations were based on several factors including model character, model type, model range, the type of inputs and outputs, and the extent of any model verification/validation. Given the large number of models evaluated, very few were found to meet any of the Emergency Support Information Requirements.

Selection of Screening Categories for Models: DOE Perspective

Dr. Jim Ellis
Lawrence Livermore National Laboratory,
Department of Energy

ABSTRACT

Emergency response activities include both facility/fixed-site emergency preparedness and response as well as deployable assets in order to protect the public from major radiological accidents and terrorist events. The concept of support includes a local modeling capability with connectivity to a centralized comprehensive modeling facility. This provides the capability to handle various applications from simple to complex at different ranges and also provides an element of consistency across DOE. There are a number of challenges in providing emergency response with the key ones including source term definition, the integration of measurements with models, obtaining multi-scale meteorology, bounding uncertainty, and the presentation of information to decision makers. The dispersion forecast is driven by meteorological factors, however the scale of meteorological forecasts is down to a few kilometers whereas the scale of required dispersion predictions is down to a few meters.

Selection of Screening Categories for Models: NRC Perspective

Dr. Stephen McGuire
Incident Response Operations,
Nuclear Regulatory Commission

ABSTRACT

A nuclear power plant incident with the potential for a radiological release will start a chronology of events involving the plant licensee, the state, and the NRC. Depending on the potential magnitude of the incident, an emergency operations center will be manned at the appropriate level, communications between all parties will be established, and dose models will be run to determine appropriate protective actions. Once the plume is released, a new set of concerns must be considered. These include the plume's path of travel and the associated deposition patterns that might lead to possible evacuations, crop interdiction, and decontamination actions. Although models will predict the path and deposition patterns, actual protective actions are based on field measurements. For transportation accidents involving smaller amounts of radioactive material, there are predetermined protective actions based on the nature of the accident. The model criteria for this application includes source characterization, dose projection, wet and dry deposition, radiological decay, and ranges on the order of ten miles. Additionally, models must be able to input both observed and forecast weather for as many as thirty-six locations.

BREAKOUT SESSION

Group 1: Planning

Co-chairs: *Mr. John S. Irwin, EPA Office of Air Quality Planning and Standards, Air Quality Modeling Group*

Dr. Darryl Randerson, Director, Special Operations and Research Division, NOAA/Air Resources Laboratory

Rapporteurs: *Maj Brian Beitler, Defense Threat Reduction Agency*

Mr. James McNitt, Office of the Federal Coordinator for Meteorology (Science and Technology Corporation)

Introduction

Breakout Group 1 considered what is required during the planning phase of a crisis. The group looked at four scenarios—a surface release of Sarin in an urban setting, explosion of a “dirty nuke,” aircraft impact with a nuclear power plant facility, and the airborne release of anthrax. The timeframe for the planning phase was defined to be the time period that starts with the planning for a potential or anticipated threat and ends with the time of the actual incident. The actions and requirements for each scenario were prioritized as high, medium, or low. A number of considerations and other issues were identified.

<u>Considerations during planning:</u>

- What could happen?
  - Most probable (credible).
  - Worst case.
  - Devise mitigation strategies.
- Importance of meteorological conditions.
  - Sources of data for planning studies.
  - Sources of data for actual events.
- Other locations (in addition to urban, including ports, sports events, complex terrain) to investigate the extent and range of effects.
- First responder considerations—what do we do at the scene of the crisis?
  - Planning estimates provide first-order estimates of the range of possible effects.
  - Sensitivity analyses can identify critical data that will be needed in an actual event.
  - Sensitivity analyses can identify the uncertainty associated with using alternate data sources.
  - Planning estimates provide a basis for training first responders (what needs to be done first, etc.).
- Defining the problems associated with the given problem.
  - Identify what is needed to assess effects in an actual event.

  - Identify a list of actions that could be taken to reduce casualties.
- Uncertainty: how do we manage this? How best do we characterize/communicate this for the customers?
  - During the planning studies, one could investigate alternative methods for communicating the uncertainties (sources, magnitude) so that decision makers have realistic expectations of what modeling can and cannot do.
- Summarize the planning results in a manner that provide useful information for potential on-site decision-makers.
- Identify and possibly devise a training schedule for use of modeling products during actual events.
- Planning studies can investigate the usefulness of having an operations center for 24/7 support. Models may be of little use initially, and may only be of use in planning possible mitigation strategies and supporting cleanup activities.
- Planning studies can investigate whether it is possible (or even useful) to attempt to convert on-site measurements to source rate and chemistry.

Other Planning Issues:

- Evaluate not only best model, but also alternative sources of information (degradation of model results).
- Evaluate the critical data needs for most effective source characterization.
- Investigate potential for converting on-scene measurements of source rates.

Results

Scenario 1 –Urban Sarin Release

Criterion	Priority
Coupling	H - M
5-min non-steady state	H (5 min)
Urban Morphology	H
Urban Dispersion	H
CFD	L
Sewer System	L
Metro	L
Wet/dry Deposition	H
Range	H (10 m –30 Km)
Indoor Air Exchange/Model	H
Complex Terrain Effects	H
Range of MET Conditions/Scale	H
Population Density/Census Data	H

Scenario 2 –Dirty Nuke

Criterion	Priority
Coupling	H
5-min non-steady state	H (5-min)
Urban Morphology	H
Urban Dispersion	H
CFD	H
Sewer System	H
Metro	H
Wet/dry Deposition	H
Range	H (100 Km)
Indoor Air Exchange/Model	H
Complex Terrain Effects	H
Range of MET Conditions/Scale	H
Population Density/Census Data	H
Cross-Media Model (food chain effects)	H
Source Characterization	H
Plume Rise	H
Blast Effects	H

Scenario 3 –Nuclear Power Plant Attack

Criterion	Priority
Coupling	H
5-min non-steady state	H (5-min)
Wet/dry Deposition	H
Range	H (1 Km to 1000 Km)
Complex Terrain Effects	H
Range of MET Conditions/Scale	H (Mesoscale features)
Population Density/Census Data	H
Cross-Media Model (food chain effects)	H
Source Characterization	H
Plume Rise	H
Down-range radiation	H
Rain-out	H
Decay Rates	H
Cloudshine	H

Scenario 4 –Crop Duster - Anthrax

Criterion	Priority
Coupling	H
5-min non-steady state	H (5-min)
Urban Morphology	H
Urban Dispersion	H
Wet/dry Deposition	H
Range	H (100 Km)
Indoor Air Exchange/Model	H
Complex Terrain Effects	H
Range of MET Conditions/Scale	H
Population Density/Census Data	H
Cross-Media Model (food chain effects)	H
Source Characterization	H
UV Effects	H
Resuspension	H
Mechanism of Release	H –Line Source

Group 2: Response

Co-chairs: *Dr. Walter Bach, Army Research Office*

Mr. Paul Bryant, Insurance and Mitigation Division, FEMA

Rapporteurs: *Mr. Thomas Fraim, Office of the Federal Coordinator for Meteorology*

Dr. Jason Ching, Air Quality Modeling Group, EPA

Introduction

Breakout Group 1 considered what is required during the response phase of a crisis involving four scenarios. These are not only actions to be taken but also modeling requirements. The scenarios were a surface release of Sarin in an urban setting, explosion of a "dirty nuke", aircraft impact with a nuclear power plant facility, and the airborne release of anthrax. The timeframe for the response phase was defined to start at the time of the incident and extend through thirty-six hours. The actions and requirements for each scenario were prioritized as high, medium, or low.

Results

Scenario 1 –Urban Sarin Release

It was noted that this is really a multi-scale problem and although a CFD type model may be required initially, as time goes on it will also become a regional scale problem requiring a different type model.

Criterion	Priority
Model the source characteristics correctly.	H
Trained personnel in source mitigation.	H
Model must be capable of handling a pooled surface source and account for various surface characteristics affecting evaporation, etc.	H
Model must incorporate micrometeorology in its interaction with the geometry and physical properties of the surface.	H
CFD type model with space resolution on the order of a meter or less and time resolution on the order of 60 seconds or less.	H
Capable of modeling the hazard to 10 km and the meteorology to 100 km.	H
Need for trained response personnel.	M

Scenario 2 –Dirty Nuke

The group felt that this would be a short-term problem given fairly large particulate matter that deposits fairly quickly, although resuspension may be a consideration. The emphasis will likely be on now-casting and immediate evacuation. It was noted that a probabilistic approach might be more appropriate than a binary yes/no approach.

Criterion	Priority
Source location and characterization.	H
Wind speed and direction.	H
Deposition (knowledge of particle size required).	H
Current and forecast precipitation and resulting spread of material by hydrologic processes.	H
Model must run quickly; i.e., fairly simple model with basic inputs.	H
Knowledge of wind variability.	M
Model should account for resuspension.	M
Building morphology and terrain	L

Scenario 3 –Nuclear Power Plant Attack

Criterion	Priority
May not have an immediate release of radioactive material, so the model should be fairly fast. This would allow running "what if" scenarios before an actual release.	H
Model should account for a time variant source term.	H
Event will be long range and long duration so model must be capable of handling out to continental scale and larger.	H
Model should be able to ingest observed and forecast weather on almost a continuous basis.	H
Model should account for radiological decay and wet/dry deposition.	H
Need a good GIS mapping capability.	H
Buoyancy/plume rise.	M
Land use.	M
Building wake effects.	L

Other issues brought up deal with coastal/lake effects and the re-circulation problem; installation of meso-nets around power plants; and the capability to run different dispersion modules similar to an ensemble approach.

Scenario 4 –Crop Duster - Anthrax

Criterion	Priority
Source characterization; e.g., release time and height, virility of material, UV interaction.	H
Model must handle small mesoscale resolution and ranges out to 100+ km.	H
Good GIS mapping capability.	H
Model must handle multiple time scales.	H
Should be able to quantify uncertainty.	H
Model should be capable of continual updating and reanalysis.	H

Common themes across all four scenarios deal were source characterization, multiple time and space scales, and multiple scales for observed and forecast meteorology inputs. A point brought up during the plenary session was that a probabilistic approach (quantify the uncertainty) may be more beneficial to the decision-maker than strictly a binary yes/no approach. Also, given the multiple time and space scales involved with the dispersion problem, we should take a systems approach. Rather than considering just a dispersion model, consider a system that may in fact have several dispersion modules each capable of dealing with different scales, sources, types of dispersion, etc.

Group 3: Recovery

Co-chairs: *Mr. James Fairobent, Office of Emergency Management, Department of Energy*

Ms. Jocelyn Mitchell, Office of Research, Nuclear Regulatory Commission

Rapporteurs: *Mr. Dennis Atkinson, Environmental Protection Agency*

Mr. Roger Stocker, Fleet Numerical Meteorology and Oceanography Center, US Navy

Introduction

Breakout group three began by defining the scope of the modeling that would be needed in the aftermath phase of any weapon of mass destruction event. It was determined that in this phase the evaluation was not as time sensitive as the other two phases considered and, therefore, sophisticated modeling could be employed in order to obtain the best estimate of impact for the four scenarios presented. This was later amended in the session to recognize that, while the final answers could take on the order of years to complete, intermediate answers within the 1-2 month time frame would be needed by decision makers. This complex modeling effort would involve collection of as many available local meteorological and effluent measurements as possible as well as a detailed source characterization. Time scales are important. The calculations would be completed by experts, so ease of code use and computer platform are not issues.

It was assumed that the audience for the products in this phase will have the luxury of time and thus results can and should be detailed and complex, involving the following:

- Forensics for chemical release
- Long term monitoring
- Decontamination and clean up
- Back calculations are necessary for some scenarios where the source location and magnitude are not known.

The group agreed on the following primary issues of interest for this modeling effort:

- Dose reconstruction
- Resuspension
- High accuracy (not knowingly biased toward conservative values)
- Calibration of instrumentation
- Specific weather data at the time of the event at appropriate scales
- Probablistic answers
- Multi-scale problems
- Some types of sources require multimedia models
- Intermediate answers - "best guess" answers may be needed before extensive study is completed

- Indoor/outdoor problem - infiltration from outside to inside and vice versa
- Runoff
- Health effects
- Long-range transport
- Some types of releases require decay correction (e.g., radioactive materials), other releases are insensitive to decay (e.g., anthrax).

In addition, for urban applications, there is a specific need to have urban-scale models. These models will require inputs for parameters important to urban modeling, such as evaporation, surface roughness, urban geometry, infiltration from outdoors to indoors and vice versa, and utilization of complex meteorology. These parameters provide more realism to the modeling and more accurately characterize the total impact in the urban environment.

Having established the end customer and the model needs, it was decided to then look at the individual scenarios and come up with lists of high and medium criteria important for each scenario. "Low" was originally dropped as a category, but ultimately a few low criteria were identified.

Each of the four scenarios was evaluated independently, but it soon became apparent that there were similarities among the scenarios with only small, but significant, differences between them. For the nuclear power plant scenario, it was assumed that a direct impact by a plane would not be expected to affect the core directly but might cause a melt down by affecting mechanical functions that control the core. This assumption would lead to a meltdown of the core at some time estimated to be between 1 hour and 1 day after the impact. Such a scenario would allow time for evacuation and monitoring to be set up by an emergency response team and would dramatically change the role of first responders.

Clean-up could take weeks, months, or years. While the site is being detoxified, residual pollutants/chemicals involved in the initial event may still be present, as well as new chemicals formed (e.g., by photochemistry or radioactive decay). On-going modeling would be important to assess human exposure during the clean-up phase.

Results

Scenario 1 –Urban Sarin Release

Criterion	Priority
Source	H
Surface Characteristics/Properties	H
Micrometeorology	H
Turbulence Characterization	H
High Resolution (DX, DZ = 1m; Dt=60 sec)	H
Interaction with Surface Geometry	H
Range	H (10 m –30 Km)
Trained Response Personnel	H

Scenario 2 –Dirty Nuke

Criterion	Priority
Incident Characteristics	H
Source Location	H
Wind Direction and Speed	H
Particle Sizes and Deposition	H
Precipitation	H
Quick Runtime	H
Simple Inputs	H
Wind Variability	M
Resuspension	M
Plume Rise	M
Stability	M
Accuracy	M
Building Morphology	L
Terrain	L

Scenario 3 –Nuclear Power Plant Attack

Criterion	Priority
Temporal Source Characterization	H
Long Range/Long Duration	H
Wet/Dry Deposition	H
Terrain	H
Weather Transitions and PBL	H
Observed and Forecast Weather(Meso-scale features)	H
On-site Met (Mobile Backup)	H
Mixed Fusion and Daughter Products	H
Quick Runtime (3 hrs)	H
GIS Mapping	H
Buoyancy/Plume Rise	M
Land Use/Boundary Layer Interaction	L
Building Wake Effects	L

Scenario 4 –Crop Duster - Anthrax

Criterion	Priority
Source Characterization (Location/Time/Virility)	H
Long Range/Long Duration	H
Deposition (Land Use; Buildings)	H
Terrain	H
Weather Transitions and PBL	H
Observed and Forecast Weather (High Resolution)	H
On-site Met (Mobile Backup)	H
Range (100+ km)	H
Multiple Time Scales	H
Measure of Uncertainty	H
Continual Update/Reanalysis	H
Quick Runtime (3 hrs)	H
GIS Mapping	H

PANEL DISCUSSION

Panel 2: Evaluation of Models

Moderator: Dr. David Rogers, *Director, Office of Weather and Air Quality, Office of Oceanic and Atmospheric Research*

Rapporteurs: Mr. Thomas Fraim, *Senior Meteorologist, Office of the Federal Coordinator for Meteorology*

Mr. James McNitt, *Office of the Federal Coordinator for Meteorology (Science and Technology Corporation)*

Synopsis

Dr. Rogers opened the session with comments regarding the importance of evaluating models in the real environment with user criteria. He noted the need to establish a comprehensive urban observing system for model evaluation that the federal agencies would fund. He proposed a test-bed in the Washington, DC area.

Dr. Rogers then introduced three speakers who discussed model evaluation processes in their respective federal agencies. An opportunity for questions and discussion followed these presentations.

A question was asked about the availability of urban databases. The DOD panel member stated that for purposes of DOD's interim model accreditation, there are three data sets deemed sufficient for urban evaluation. These are the Salt Lake City data set, the Los Angeles data set used for MIDAS AT, and the UK data set used for the Urban Dispersion Model (UDM) evaluation. It was noted however, that additional urban data will be required in order to fully accredit the DOD's new Joint Effects Model (JEM). The planned Oklahoma City experiment in July 2003 will provide an opportunity to gather more data in an urban environment. Following a comment that the Los Angeles data set consists of SF_6 releases in downtown Los Angeles over a several day period, the EPA panelist emphasized the point that in the future, longer time period data sets will be needed in order to deal with evaluation statistically. In that regard, he stated that Project Prairie Grass was a well designed experiment the data from which has withstood the test of time.

In keeping with the idea of longer period data sets, there was some discussion on the notion of a long-term study in the Washington, DC area. This would allow for the development of probability distributions rather than just discrete concentrations in space and time. Another point of view was raised from the audience with respect to probability distributions. The point was stressed that the user generally wants a definitive answer and isn't real interested in probabilities. It was pointed out that perhaps there is a communication problem and it might be better to build the uncertainties into the definitive forecast rather than passing them on to the user and leaving the interpretation up to him. However, in order to do this, the user must communicate his thresholds to the forecaster so the final answer incorporates all user sensitivities. It was noted by the DOD panel member that the DOD's Chemical Stockpile Emergency Preparedness Program (CSEPP) has worked with states and counties to establish thresholds and that within minutes of an event using D2PC, information is available for the decision maker.

A question arose regarding what criteria might be used for deciding whether models are performing satisfactorily. There was some discussion as to whether a Figure of Merit (FOM) or some other measure such as median or mode should be used. The DOD panelist stressed the need to balance "falsely warned" with "falsely unwarned" (i.e., false alarms with missed events) and that the user should decide his tolerance for one or the other. It was also noted that the DOD accepts a certain degree of risk that might not be acceptable with civilian populations. The EPA panelist noted that in urban situations the models are showing a great deal of sensitivity to multi-scale issues (e.g., building morphologies). In this regard, it was emphasized that models should be evaluated for their intended purpose and that the evaluations should be organized with respect to the appropriate scale(s).

The panel moderator brought up the notion of a continuous evaluation of the models running in real-time. For example, NOAA is running HYSPLIT continuously for a number of locations, so ample model data would be readily available for a statistical evaluation. The DOD panelist responded that this might be possible for a limited number of scenarios, but for the DOD, the number of possible combinations is too numerous. Rather than this approach, the DOD would like to implement nowcasting so that real-time weather is available soon after an event happens. The DOD is also looking at denser weather data networks to benefit various applications including transport and diffusion. The EPA panelist mentioned the need for a continuous source of some kind to make such evaluations viable. He also mentioned that the EPA and NOAA are embarking on a program to continuously forecast ozone. This effort might benefit the continuous running of models for other applications including transport and diffusion. A member of the audience highlighted the need to develop the capability to examine the flow field using remote sensing, especially satellite and radar. This would provide supporting weather data in areas where mesoscale observing networks have not been deployed.

The moderator wrapped up the discussion by emphasizing a point that had come up several times during the session: the user must be engaged in any development of new tools and capabilities.

Evaluation of Models
Department of Defense

LTC Jerry A. Glasow, US Army
Assistant to the Deputy Assistant Secretary of Defense
for Chemical and Biological Defense

ABSTRACT

The Department of Defense (DOD) acquisition policies require verification, validation, and accreditation (VV&A) of models developed or procured by the department. However, because no model gives the "right" answer, it is important that models be evaluated based on their ability to fulfill their intended use. This concept is referred to as "fitness for use." In the past, fitness for use and VV&A were not linked. In order to encourage this aspect of evaluation, the DOD is attempting to link evaluation for fitness for use to VV&A. Developers are encouraged to use measures of effectiveness (MOEs) that are quantifiable and measurable. An example is consequence assessments. When modeling the consequences of a chemical or biological attack there is a need to reasonably represent the number and types of causalities.

Test and evaluation should address effectiveness, suitability, maintainability, and survivability. Independent T&E is mandated by Congress. Operational test and evaluation should address the following:

- Operational effectiveness – does the model do what it was designed to do?
- Operational suitability – can the model be used by the person who will use it?

Example Measures of Effectiveness (MOE):

- minimize false warning and false non-warning
- acceptable casualties
- quantity of agent

Accreditation is critically important. Upon completion of testing, the decision-maker must put the stamp of approval on a model.

Evaluation of Models
Department of Energy

Dr. Jim Ellis
Lawrence Livermore National Laboratory,
Department of Energy

ABSTRACT

Methodologies for evaluating models include

- peer review
- test and analyze solutions against known solutions
- conduct tracer field experiments
- conduct operational systems tests in the operational environment.

When testing analytic solutions one must ensure the right equations are being used (i.e., is the science valid) and that they are being solved correctly in three dimensions (i.e., have they been encoded correctly). Tracer field experiments test the validity of models in the real world with the added consideration that the multiple scales must be modeled. The evaluator can use graphical and statistical measurements of model performance.

Examples of tracer field experiments that have been conducted are:

- Project Prairie Grass
- Savannah River
- Diablo Canyon tracer study (complex terrain)
- ETEX (European tracer experiment)
- VTMX/URBAN

DOE and DOD are planning an urban field experiment in 2003 for Oklahoma City, OK.

Evaluation of Models
Environmental Protection Agency

Mr. John S. Irwin, NOAA Meteorologist
EPA Office of Air Quality Planning and Standards,
Air Quality Modeling Group

ABSTRACT

The EPA has a long history of model evaluation. The Clean Air Act of 1977 required the EPA to define models for air quality. As part of this effort, EPA developed model evaluation methods (Oreskes et al, 1994, Science (263), 641-646).

Initially the EPA ran into trouble by focusing on the intended use of the models. This is because of the uncertainties involved. When you evaluate a model for extreme values against observations then you are comparing garbage to reality. The answer to the problem was to create an evaluation procedure that uses statistical evaluation test methods to do three things:

- assure that the physics are right in the model (label the model as a "best performer")
- determine whether differences seen in the performance of the models are statistically significant (identify other models that may be performing as well, i.e., a "set of best performers")
- compare the models' results to each other in an open and fair competition in which the rules are known and the conclusions reached are objectively determined

Once the "set of best performers" has been defined, then a new set of statistical evaluation test methods would be used to determine which of these models best performs the user-defined tasks. The following test methods provide promising results:

- grouped data
- decomposed time series
- process analyses.

The American Society for Testing and Materials (ASTM) is developing model evaluation standard guidelines. Those interested in model evaluation should consider joining the ASTM and to contributing to this effort.

WRAP-UP

Col Judson E. Stailey, USAF
Assistant Federal Coordinator for
Air Force and Army Meteorological Affairs,
Office of the Federal Coordinator for
Meteorological Services and Supporting Research

Summary and Next Steps

Based on the results of the workshop, OFCM will address follow-up and development of related issues in three phases—near term, mid term, and long term.

Near Term—Results of the Workshop

The OFCM staff will consolidate the results of the workshop, particularly the scenarios and associated criteria, and forward that information to participants for review and comment. Participants were asked to review the criteria and scenarios (including modifications to workshop scenarios and suggestions for additional scenarios) and provide any comments they might have to the breakout group chairs. OFCM will convene a Joint Action Group (JAG) to investigate additional scenarios and apply the criteria to existing models.

Mid Term—Evaluation of Models

In the two-to-six-month timeframe, the JAG will investigate the status of ATD model evaluation within the federal agencies and work toward establishing an agreed-upon set of steps for evaluating models across those agencies. In addition, the JAG will identify model shortfalls and consider research priorities to fill those gaps. Toward the end of the period, the results of the work on model evaluation and technical shortfalls will be presented to the agencies along with recommended actions. During this period OFCM will publish the proceedings of this workshop.

Long Term—Strategic Planning

In the six-to-twelve-month timeframe, a plan will be devised to address the technological shortfalls identified during the previous phase and to follow-up on any broadly accepted process for evaluating ATD models. Finally, consideration will be given to identifying or developing a community ATD model or toolkit of models to be used for ATD.

Mr. Samuel P. Williamson
Federal Coordinator
Office of the Federal Coordinator for
Meteorological Services and Supporting Research

Closing Remarks

Mr. Williamson reviewed the goal and objectives of the workshop. He noted that in spite of the challenges inherent in the subject of ATD models, considerable progress had been made. This progress was due almost entirely to the active involvement of the participants, with the help of the moderators, panelists, and session co-chairs. Mr. Williamson committed to establishing a joint action group to continue a detailed review and assessment of models. He closed by thanking all participants for making the workshop a success.

APPENDIX A - AGENDA

WORKSHOP ON
EFFECTIVE EMERGENCY RESPONSE

December 5-6, 2001

Crowne Plaza Washington National Airport
Crystal City, Virginia

Wednesday, December 5th

8:30 a.m. **Registration**

1:30 p.m. **Introduction**

Welcome/Objectives: Mr. Samuel P. Williamson (*Federal Coordinator for Meteorology*)

Set the Stage: Col Jud Stailey (*Assistant Federal Coordinator for Air Force and Army Affairs, OFCM*)

2:00 p.m. **Panel Discussion: Selection of Screening Categories for Models—**Moderator: Mr. Bruce Hicks (Director, Air Resources Laboratory, NOAA)

Panelists:

Dr. Steven McGuire (Incident Response Operations, NRC)

Mr. John Irwin (Air Quality Modeling Group, EPA)

CAPT Frank Garcia, Jr., USN (Acting Director, Information Systems, ODUSD (S&T))

Mr. Paul Bryant (Mitigation Division, FEMA)

Dr. Jim Ellis (Lawrence Livermore National Laboratory, DOE)

Discussion

5:00 p.m. **Adjourn for the Day**

Thursday, December 6th

7:30 a.m. **Late Registrations and Continental Breakfast**

8:30 a.m. **Breakout groups: Development of Standard Criteria within the Screening Categories** (Categories from previous day divided among groups)

Planning: Co-chair: Mr. John Irwin (Air Quality Modeling Group, EPA) and Dr. Darryl Randerson, (Director, Special Operations and Research Division, NOAA/ARL)

Response: Co-chair: Dr. Walter Bach (Army Research Office) and Mr. Paul Bryant (Mitigation Division, FEMA)

Recovery3: Co-chair: Mr. Jim Fairobent (Office of Emergency Management, DOE) and Ms. Jocelyn Mitchell (Office of Research, NRC)

11:45 a.m. **Lunch** (Provided)

1:00 p.m. **Reports from Breakout Groups**—Moderator: Mr. Floyd Hauth (*OFCM/STC Corporation*)

2:00 p.m. **Panel Discussion: Evaluation of Models—**Moderator: Dr. David Rogers (Director, Office of Weather and Air Quality, Office of Oceanic and Atmospheric Research*)*

Panelists:

Department of Defense: *LTC Jerry A. Glasow, USA (Assistant to the Deputy Assistant Secretary of Defense for Chemical And Biological Defense)*

Department of Energy: *Dr. Jim Ellis (Lawrence Livermore National Laboratory, DOE)*

Environmental Protection Agency: *Mr. John S. Irwin (Air Quality Modeling Group, EPA)*

Discussion

4:30 p.m. **Wrap-up**

Summary and Next Steps—Col Jud Stailey (*Assistant Federal Coordinator for Air Force and Army Affairs, OFCM*)

Closing Remarks—Mr. Samuel P. Williamson (*Federal Coordinator for Meteorology*)

5:00 p.m. **Adjourn**

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APPENDIX C - PRESENTATIONS

Due to the volume of presentations and to take advantage of web technology, the presentations made during this workshop are available on the OFCM website under Special Projects.

The URL is <http://www.ofcm.gov>.